Indicator: Pesticide Residues in Food (064)

More than one billion pounds of pesticides and herbicides are used in the United States each year to control weeds, insects, and other organisms that threaten or undermine human activities (Aspelin, 2003). Some of these compounds can be harmful to humans if ingested, inhaled, or otherwise contacted in sufficient quantities (see Indicator "Urinary Pesticide/Herbicide Level"). Potential health effects vary by chemical. The primary routes of exposure for the general population are ingestion of a treated food source and contact with applications in or near residential sites. Pesticides may also be harmful in the environment when non-target organisms are exposed (U.S. EPA, 2003).

This indicator represents data from the U.S. Department of Agriculture's Pesticide Data Program (PDP) which measures pesticide residue levels for more than 290 pesticides and their metabolites in fruits, vegetables, grains, meat, and dairy products from across the country, sampling different combinations of commodities each year. PDP data collection began in 1991 and includes both domestic and foreign-produced commodities. Results are published in annual reports, which include statistics on the number of pesticide residues detected, the number of residues exceeding the tolerance established by EPA for a given pesticide-commodity pair (Code of Federal Regulations, Title 40, Part 180), and the number of residues detected for which no tolerance has been established. This indicator depicts data from 1994 to 2003; data prior to 1994 are considered less reliable. Between 1994 and 2003, the number of food samples analyzed per year ranged from 5,771 to 12,899.

What the Data Show

Overall, the percent of samples with no detectable pesticide residues increased during the period from 1994 to 2002 (Figure 064-1). Samples with no detects accounted for 38.5% of samples analyzed in 1994 and rose to 57.9% of samples in 2002. Data for 2003 cannot be compared directly to the previous years' data due to a change in the way that detects are counted. During the same period, each of the other categories (i.e., samples with one or more detected residues) remained steady or declined slightly. For example, in 1994, 9.8% of samples were found to contain four or more pesticide residues; this figure dropped to 8.2% in 2002. The stable or slightly declining trend in number of detects occurred at the same time that analytical limits of detection for these compounds have been decreasing, allowing the instruments to pick up ever smaller concentrations.

The amount of residue detected for pesticides with established tolerance limits is examined in Figure 064-2. This figure illustrates the percentage of samples in which at least one residue was detected at a concentration exceeding the tolerance established by EPA for a given pesticide-commodity pair. The percentage of samples exceeding EPA tolerance values increased from 0.05% in 1994 to 0.31% in 2003 (Figure 064-2). In addition, the bars in figure 064-2 show that the number of samples analyzed each year increased nearly 50 percent between 1994 and 2003.

Figure 064-3 shows the percentage of samples containing at least one residue without an established EPA tolerance for the commodity on which it was detected. This number represents pesticides detected on crops for which they are not registered to be used and may be the result of spray drift, crop rotation, or other environmental contamination as well as unregistered use. Between 1999 and 2003, the percentage of samples in this category decreased overall from 3.7 to 1.5 percent and showed an irregular trend.

Indicator Limitations

- Among the data for number of residues detected (Figure 064-1), in 2003, measurement of a parent compound and/or any of its metabolites was counted as a single detect whereas in previous

years, parent compounds and each of their metabolites were counted as separate detects. Therefore numbers from 2002 and earlier cannot be compared directly with the data from 2003.

- The PDP does not sample all commodities over all years, so some gaps in coverage exist. Differences in the percent of detections for any given class of pesticides might not be due to an increase (or decrease) in the predominance of detectable residues, but might simply reflect the changing nature and identity of the commodities selected for inclusion in any given time frame.
- The PDP has the ability to detect pesticide residues at concentrations that are orders of magnitude lower than those determined to have human health effects. The presence of detectable pesticide residues in foods is not necessarily indicative of a potential health concern (USDA, AMS, 2002).

Data Sources

U.S. Department of Agriculture (USDA), Pesticide Data Program. Annual summary reports available at http://www.ams.usda.gov/science/pdp.

References

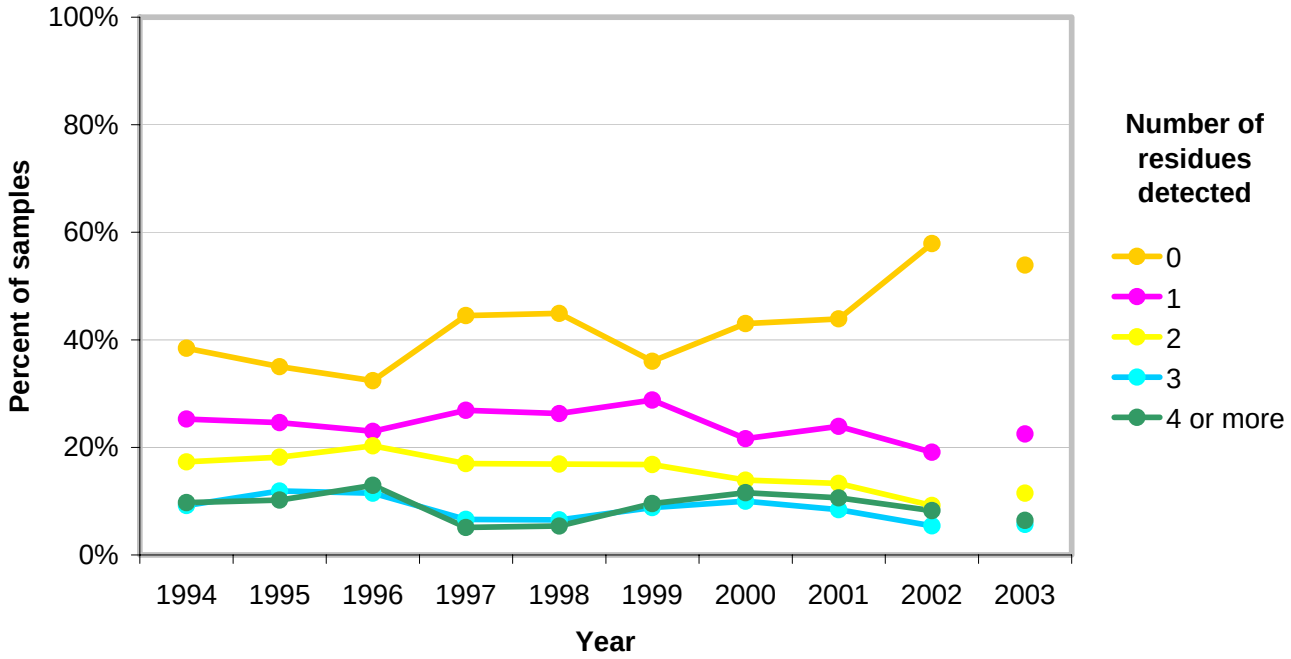
Aspelin AL. 2003. Pesticide Usage in the United States: Trends During the 20th Century. Raleigh, NC: Center for Integrated Pest Management, North Carolina State University. February 2003. http://www.pestmanagement.info/pesticide_history/index.pdf.

Food and Drug Administration. 2004. FDA Pesticide Program Residue Monitoring 1993-2002. http://vm.cfsan.fda.gov/~dms/pesrpts.html.

U.S. Environmental Protection Agency. 2003. Pesticides: Regulating Pesticides: Data Requirements. http://www.epa.gov/pesticides/regulating/data.htm

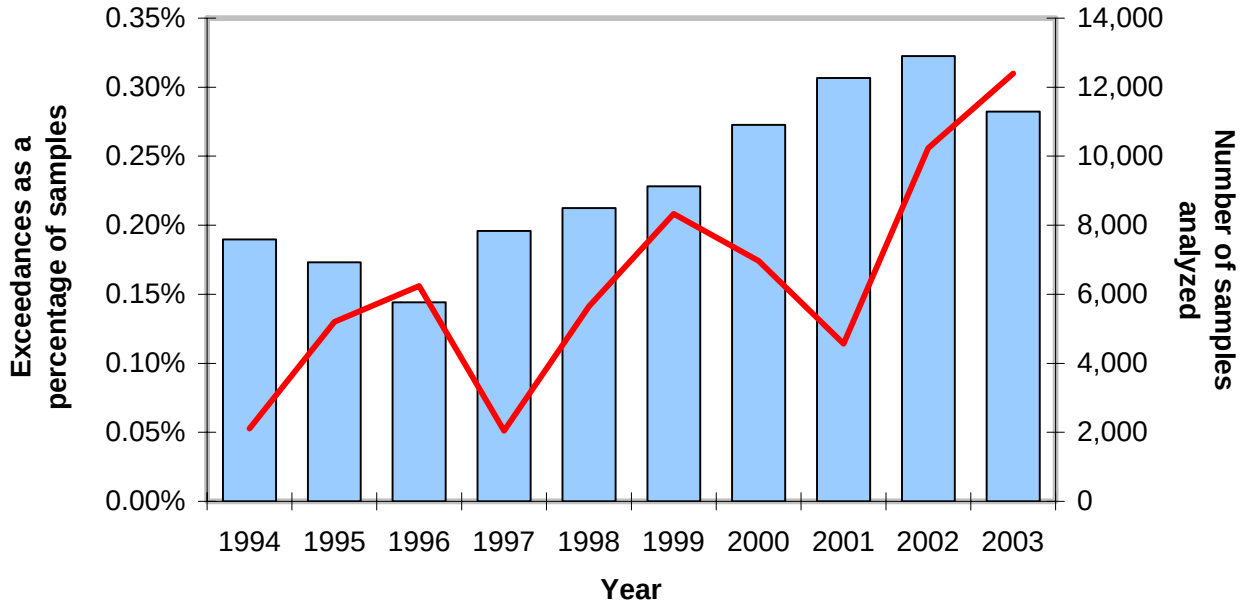
Graphics

Figure 064-1: Pesticide detects in food, 1994-2003



Data Source: United States Department of Agriculture (USDA), Pesticide Data Program. Annual summary reports available at <http://www.ams.usda.gov/science/pdp/download.htm#reports> Graphical interpretation by USEPA.
Data for 2003 parent compounds and their metabolites are combined to report the number of "pesticides" rather than the number of "residues", as was reported in previous years' summaries. For example, a sample with positive detections for Endosulfan I, II, and sulfate would have been counted as three residues detected in the 2002 Appendix L. That same sample would be counted as just one pesticide detected in the PDP summary 2003 Appendix M

Figure 064-2: Pesticide tolerance exceedances, 1994-2003

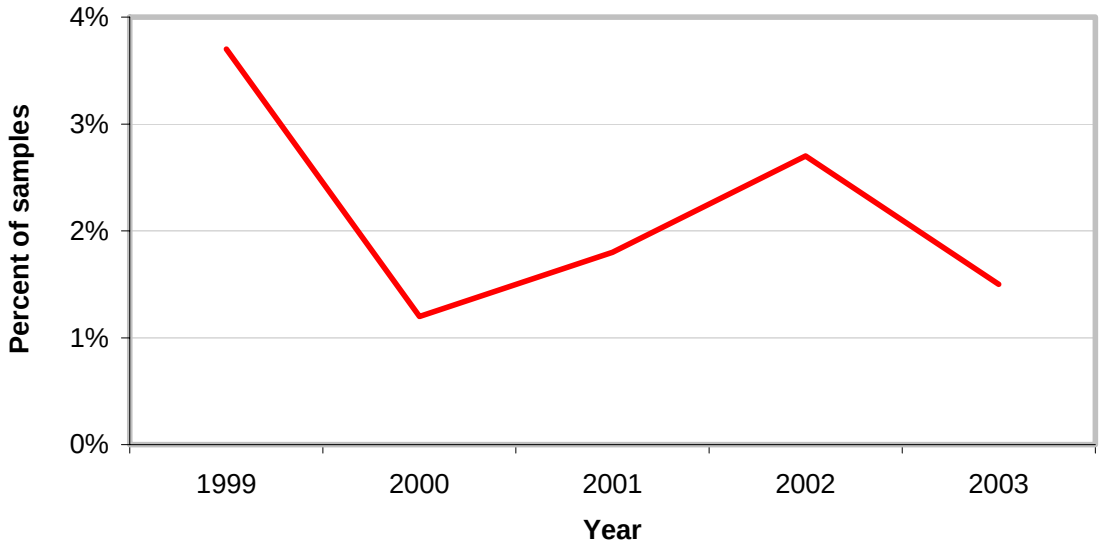


Data Source: United States Department of Agriculture (USDA), Pesticide Data Program. Annual summary reports available at http://www.ams.usda.gov/science/pdp/download.htm#reports
Graphical interpretation by USEPA.
The number of samples analyzd represented by the blue bars are the total number of samplesfor each year and represent a variety of different commodities that are rotated in and out of the program over time.

Number of samples

Percentage of samples exceeding tolerance

Figure 064-3: Detected residues of pesticides with no established tolerance, 1994-2003



Data Source: United States Department of Agriculture (USDA), Pesticide Data Program. Annual summary reports available at http://www.ams.usda.gov/science/pdp/download.htm#reports
Graphical interpretation by USEPA.

R.O.E. Indicator QA/QC

Data Set Name: PESTICIDE RESIDUES IN FOOD
Indicator Number: 064 (89303)
Data Set Source: USDA PDP Monitoring Database
Data Collection Date: 1993-2003
Data Collection Frequency: Daily
Data Set Description: Pesticide Residues in Food
Primary ROE Question: What are the trends in chemicals used on the land and their effects on human health and the environment?(Chemicals to include toxic substances, pesticides, fertilizers, etc.)

Question/Response

T1Q1 Are the physical, chemical, or biological measurements upon which this indicator is based widely accepted as scientifically and technically valid?

Yes. The measurements upon which this indicator is based are widely accepted as scientifically and technically valid. PDPs monitoring data are considered the gold standard by those in the field of pesticide residues in/on food. Data quality is excellent and follows written Standard Operating and QA/QC procedures based on EPA Good Laboratory Practices. In the most recent sampling year, eleven laboratories across the U.S. (8 State and 3 Federal) performed these analyses consistently by using these written SOPs. Laboratory staff receive and maintain intensive training programs and must demonstrate analytical proficiency on an ongoing basis. State-of-the-art instrumentation is used and detection limits are very sensitive (low ppb levels). The analytical methodologies detect multiple pesticides and detects are verified by a second confirmatory method. Many of the SOPs are located at the following web site address: http://www.ams.usda.gov/science/pdp/SOPs.htm

T1Q2 Is the sampling design and/or monitoring plan used to collect the data over time and space based on sound scientific principles?

The sampling design is nationally based and represents the annual market of commodities purchased in the United States. (see T3Q3 for details).

T1Q3 Is the conceptual model used to transform these measurements into an indicator widely accepted as a scientifically sound representation of the phenomenon it indicates?

Yes. These are real data that are used directly in risk assessments.

T2Q1 To what extent is the indicator sampling design and monitoring plan appropriate for answering the relevant question in the ROE?

PDP concentrates its efforts in providing better pesticide residue data on foods most consumed by children. This PDP policy is guided by the requirements of the 1996 Food Quality Protection Act and by recommendations made in 1993 by the National Academy of Sciences (NAS) in "Pesticides in the Diets of Infants and Children." <http://www.nas.edu/> . For any goal related to pesticides exposure or safe food, the PDP data provide continuing, extensive information on pesticide residues in fruits, vegetables, grains, dairy products, and meats. Thousands of samples have been analyzed for over a hundred pesticides and their metabolites on dozens of commodities. This program has been in continual operation since 1992 and has produced valuable

data on pesticide residues on food commodities at markets and warehouses. Samples are collected by USDA immediately before commodities are shipped to grocery stores and supermarkets, and prepared by the laboratory as they typically would be for consumption (i.e., they are washed, peeled, cored, etc.). PDP data thus are more likely to reflect actual exposures than other data based, for example, on farm-gate sampling. The PDP data provide an excellent measure of pesticide residues in produce and other food commodities at a point very close to consumption by the general public.

T2Q2 To what extent does the sampling design represent sensitive populations or ecosystems?

PDP concentrates its efforts in providing better pesticide residue data on foods most consumed by children, who may be more sensitive to pesticides than adults because of their body size and metabolism. This indicator is based on data from the USDA Pesticide Data Program (PDP). PDP s data on pesticides in selected commodities are collected and analyzed to strengthen the government s ability to respond to food safety and marketing concerns, to protect public health, and to provide EPA with data needed to implement the Food Quality Protection Act. PDP operations are guided by recommendations presented to the U.S. Congress by the National Academy of Sciences report Pesticides in the Diets of Infants and Children, (1993). In this report, the NAS examined a variety of scientific and policy issues that need to be addressed when regulating pesticides in foods. The report recommended new ways and approaches for assessing pesticide risks to infants and children, which required better information on food consumption patterns of infants and children and pesticide residue data on foods most consumed by infants and children. OPP has identified a list of commodities that are considered major items of consumption by children using data collected from the USDA s Continuing Surveys of Food Intakes by Individuals. The PDP program and sample collection effort was initiated and sustained to address the issue of providing better pesticide residue data on foods most consumed by children.

T2Q3 Are there established reference points, thresholds or ranges of values for this indicator that unambiguously reflect the state of the environment?

Yes, a tolerance is a legal reference point with regards to commodities in channels of trade but this should not be related to a threshold for environmental quality.

T3Q1 What documentation clearly and completely describes the underlying sampling and analytical procedures used?

Data quality is excellent and follows written Standard Operating and QA/QC procedures based on EPA Good Laboratory Practices. In the most recent sampling year, eleven laboratories across the U.S. (8 State and 3 Federal) performed these analyses consistently by using these written SOP s http://www.ams.usda.gov/science/pdp/SOPs.htm Laboratory staff receive and maintains intensive training programs and must demonstrate analytical proficiency on an ongoing basis. State-of-the-art instrumentation is used and detection limits are very sensitive (low ppb levels). The analytical methodologies detect multiple pesticides and detects are verified by a second confirmatory method. Many of the SOPs are located at the following web site address: http://www.ams.usda.gov/science/pdp/SOPs.htm

T3Q2 Is the complete data set accessible, including metadata, data-dictionaries and embedded definitions or are there confidentiality issues that may limit accessibility to the complete data set?

Yes, the data are available to the public in its entirety. http://www.ams.usda.gov/science/pdp Deputy Director Diana Haynes 703.3330.2300 ext. 34

T3Q3 Are the descriptions of the study or survey design clear, complete and sufficient to enable the study or survey to be reproduced?

Yes. Sampling Operations: PDP samples are collected by 10 participating States, which represent about 50 percent of the Nation's population and all regions of the country. Samples are collected close to the point of consumption. Collection at terminal markets and large chain store distribution centers allows the capture of sample identity data, takes into account pesticide degradation during transit and storage, and provides data on residues from post-harvest applications of fungicides and growth regulators. Sample sizes for all fresh fruit and vegetables are 3 to 5 pounds; processed products are 1 to 3 pounds; milk, corn syrup, and juices are 1 quart; and grains, poultry, and beef are 1 pound. For some commodities (such as grains, poultry, and beef), Federal personnel perform sample collection because of access and expertise in product collection, packaging, and shipping. The number of samples to be collected is apportioned according to State population or commodity production figures. Samples are randomly chosen without regard for commodity origin or variety. Samples reflect what is typically available to consumers throughout the year. PDP's statistically-reliable sampling protocol is designed to select random samples that best represent pesticide residues in the food supply to allow for realistic estimates of exposure to these chemicals. All participating States, except California, ship samples to a single laboratory for dedicated commodity analysis. All California samples are tested at the California lab. PDP maintains Standard Operating Procedures (SOPs) designed to provide criteria to State samplers for site selection and specific instructions for sample selection, shipping, and handling. Support and oversight for all sampling operations is provided by USDA's National Agricultural Statistics Service (NASS). Detailed information about PDP sampling operations can be found in Section II of the PDP 2003 Annual Summary. http://www.ams.usda.gov/science/pdp/Download.htm#reports Laboratory Operations Analytical services are provided by nine State and two Federal laboratories. Participation as a contributing laboratory is voluntary and is funded through a Cooperative Agreement between the laboratory and USDA. Upon receipt, samples are visually examined for acceptability and are discarded if determined to be inedible (decayed, extensively bruised, or spoiled). Accepted samples are prepared (washed with inedibles removed) emulating consumer practices. All sample preparations are controlled by program-wide Standard Operating Procedures (SOPs) that ensure consistency between laboratories. Samples are mixed or homogenized into one representative composite sample. Residues are isolated from composite samples using various extraction and clean-up procedures. Extracts are then ready for instrumental analysis. PDP also conducts special surveys on single-serving food items to support acute dietary risk exposure studies. PDP Laboratories continuously evaluate and utilize state-of-the-art instrumental systems when conducting initial identification and quantification of pesticides. All extraction methods and instrumental systems are independently validated by the laboratory performing the analysis. PDP requires continuous quality assurance (QA) controls and on-site monitoring by independent QA officers to ensure the reliability of PDP data. Performance equivalency of the participating laboratories is monitored by a program-wide check sample program. All residues initially identified are verified using various forms of mass spectrometry, atomic emission detectors, or alternate detection systems. PDP laboratories also report non-detects for all pesticides screened, with corresponding reference Limits of Detection (LOD). Detailed information about PDP laboratory operations can be found in Section III of the PDP 2003 Annual Summary.

T3Q4 To what extent are the procedures for quality assurance and quality control of the data documented and accessible?

USDA started PDP in May 1991 to test commodities in the U.S. food supply for pesticide residues. PDP has tested over 50 different commodities: fresh/frozen/canned fruit and vegetables, fruit juices, whole milk, grains, corn syrup, poultry, beef, and drinking water. PDP has tested for more than 290 different pesticides: insecticides, fungicides, herbicides, and growth regulators. PDP samples are collected by 10 participating States, which represent about 50 percent of the Nation's population and all regions of the country. All California samples are tested at the California lab. PDP maintains Standard Operating Procedures (SOPs) designed to provide criteria to State samplers for site selection and specific instructions for sample selection, shipping, and handling. Support and oversight for all sampling operations is provided by USDA's National Agricultural Statistics Service (NASS). Detailed information about PDP sampling operations can be found in Section II of the PDP 2003 Annual Summary. Analytical services are provided by 9 State and 2 Federal laboratories. All extraction methods and instrumental systems are independently validated by the laboratory performing the analysis. PDP requires continuous quality assurance (QA) controls and on-site monitoring by independent QA officers to ensure the reliability of PDP data. Performance equivalency of the participating laboratories is monitored by a program-wide check sample program. Detailed information about PDP laboratory operations can be found in Section III of the PDP 2003 Annual Summary. Database Management & Reporting PDP maintains an electronic database which serves as a central repository for its residue monitoring data. The data captured and stored in the PDP database include product information, residue findings, and process control recoveries for each sample collected and analyzed, plus fortification results for each set of samples. Data for each calendar year are stored in a separate database structure, allowing for easier administration and reporting of data. PDP utilizes a customized Web-based software application package that provides participating laboratories with the ability to enter the PDP data into interactive data entry screens using just a Web browser and Internet access. The data are stored directly into a central database that resides in Washington, D.C. Ad hoc queries and customized reports are generated in response to data requests from government agencies and the public sector. PDP calendar year databases are available for download on the Download Data/Reports page. PDP has published Annual Summary reports to present program findings for calendar years 1991 through 2003. Detailed information about PDP database management and reporting activities can be found in Section IV of the PDP 2003 Annual Summary. http://www.ams.usda.gov/science/pdp/SOPs.htm

T4Q1 Have appropriate statistical methods been used to generalize or portray data beyond the time or spatial locations where measurements were made (e.g., statistical survey inference, no generalization is possible)?

Yes. Database Management & Reporting PDP maintains an electronic database which serves as a central repository for its residue monitoring data. The data captured and stored in the PDP database include product information, residue findings, and process control recoveries for each sample collected and analyzed, plus fortification results for each set of samples. Data for each calendar year are stored in a separate database structure, allowing for easier administration and reporting of data. PDP utilizes a customized Web-based software application package that provides participating laboratories with the ability to enter the PDP data into interactive data entry screens using just a Web browser and Internet access. The data are stored directly into a central database that resides in Washington, D.C. Ad hoc queries and customized reports are generated in response to data requests from government agencies and the public sector. PDP calendar year databases are available for download on the Download Data/Reports page. PDP has published Annual Summary reports to present program findings for calendar years 1991 through 2003. Detailed information about PDP database management and reporting activities can be found in Section IV of the PDP 2003 Annual Summary.

T4Q2 Are uncertainty measurements or estimates available for the indicator and/or the underlying data set?

No. The only the limit is that of the detection and quantifications during analysis.

T4Q3 Do the uncertainty and variability impact the conclusions that can be inferred from the data and the utility of the indicator?

No.

T4Q4 Are there limitations, or gaps in the data that may mislead a user about fundamental trends in the indicator over space or time period for which data are available?

There are no limits or gaps in the data that would substantially mislead a user about fundamental trends in pesticide residues. The data are collected in such a manner to be representative of the U.S. food supply. While all foods are not sampled by the PDP program, the foods that are sampled are major items of consumption. The PDP program analyzes for several hundred pesticides and their metabolites and thus this represents a broad cross-section of insecticides, herbicides, and fungicides. There are no plans at this point to stop the data from continuing being generated.